

CLAIMS

What is claimed is:

1. A energy balance circuit for a charger to evenly charge a battery set with a first battery and a second battery connected in series, comprising:

5 a first current storage device, whose one end is coupled to the positive output terminal of the battery set;

 a voltage storage device, which is coupled to the first current storage device in series using one end;

10 a second current storage device, which is coupled to the voltage storage device in series using one end and coupled to the negative output terminal of the battery set using the other end;

 a first switch, whose one end is coupled between the first current storage device and the voltage storage device and the other end coupled between the first battery and the second battery; and

15 a second switch, whose one end is coupled between the second current storage device and the voltage storage device, and the other end coupled between the first battery and the second battery;

20 wherein the switches are rapidly turned on and off in such a way that the switch corresponding to the battery with a higher terminal voltage is turned on and off at a high frequency so that the energy in the battery with the higher terminal voltage charges the corresponding current storage device and the energy stored in the voltage storage device charges the battery with the lower terminal voltage.

2. The circuit of claim 1, wherein the first switch and the second switch are turned

on and off alternately.

3. The circuit of claim 1, wherein the first switch is a controllable power switch.
4. The circuit of claim 1, wherein the second switch is a controllable power switch.
5. The circuit of claim 1, wherein the first current storage device is an inductor.
- 5 6. The circuit of claim 1, wherein the second current storage device is an inductor.
7. The circuit of claim 1, wherein the voltage storage device is a capacitor.
8. The circuit of claim 1, wherein the first and the second current storage devices are coupled inductors.
9. A battery set module, comprising:
 - 10 a plurality of batteries connected in series to form a battery set;
 - a plurality of balance charging loops, each of which is connected to the batteries in parallel and contains a switch and a current storage device connected in series; wherein one end of the switch is coupled to the positive output terminal of the battery and the other end coupled to the current storage device,
 - 15 a voltage storage device coupled between the current storage devices;
 - wherein the switches are turned on and off at a fixed frequency in such a way that the switch corresponding to the battery with a higher terminal voltage is turned on and off at a high frequency so that the energy in the battery with the
 - 20 the higher terminal voltage charges the corresponding current storage device and the energy stored in the voltage storage device charges the battery with the lower terminal voltage.

10. The battery set module of claim 9, wherein the switches in the balance charging loops are turned on and off alternately.

11. The battery set module of claim 9, wherein each of the switches is a controllable power switch.

5 12. The battery set module of claim 9, wherein the current storage device is an inductor.

13. The battery set module of claim 9, wherein the voltage storage device is a capacitor.

10 14. The battery set module of claim 9, wherein the switches are turned on and off alternately at a high frequency.

15. A battery set module with a charger to charge serially connected batteries evenly, comprising:

N batteries, which are connected in series; and

15 N-1 energy balance circuits, each of which has an upper node, a middle node, and a lower node;

20 wherein each of the energy balance circuits is connected to the batteries in parallel through the upper node, the middle node, and the lower node in an overlapped fashion, so that the upper node N1 of the first energy balance circuit is connected to the positive pole of the first battery, its lower node N3 is connected to the negative pole of the second battery, and the middle node N2 is connected between the first battery and the second battery; and the upper node of each of the successive energy balance circuits is connected to the middle node of its previous energy balance circuit, the middle node of each of the successive energy balance circuits is connected to the lower node of its previous energy balance circuit, and the lower mode of each of the successive

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energy balance circuits is connected to the negative pole of the corresponding battery, until the lower node of the last energy balance circuit is connected to the negative pole of the last battery.

16. The battery set module of claim 15, wherein the energy balance circuit further
5 comprises:

a first current storage device, whose one end is connected to the upper node of the energy balance circuit;

a voltage storage device, which one end is coupled to the first current storage device in series;

10 a second current storage device, which is connected to the voltage storage device in series with one end coupling to the lower node of the energy balance circuit;

15 a first switch, whose one end is coupled between the first current storage device and the voltage storage device and the other end coupled to the middle node of the energy balance circuit; and

a second switch, whose one end is coupled between the second current storage device and the voltage storage device, and the other end coupled to the middle node of the energy balance circuit;

20 wherein the switches are turned on and off at a fixed frequency in such a way that the switch corresponding to the battery with a higher terminal voltage is turned on and off at a high frequency so that the energy in the battery with the higher terminal voltage charges the corresponding current storage device and the energy stored in the voltage storage device charges the battery with the lower terminal voltage.

25 17. The battery set module of claim 16, wherein the first and second switches are

turned on and off alternately and rapidly.

18. The battery set module of claim 16, wherein the first switch is a controllable power switch.

19. The battery set module of claim 16, wherein the second switch is a controllable
5 power switch.

20. The battery set module of claim 16, wherein the first current storage device is an inductor.

21. The battery set module of claim 16, wherein the second current storage device is an inductor.

10 22. The battery set module of claim 16, wherein the voltage storage device is a capacitor.

23. The battery set module of claim 16, wherein the first and second current storage devices are coupled inductors.